

## CLAIMS

What is claimed is:

1. An apparatus for processing a digital data stream from multiple users, comprising:
  3. an initial amplitude estimation unit processing said data stream and producing initial amplitude estimates on a first iteration;
  5. a joint amplitude estimator coupled to said data stream and said initial amplitude estimator, wherein said joint amplitude estimator produces updated amplitude estimates;
  8. a symbol estimator coupled to said data stream, said initial amplitude estimator, and said joint amplitude estimator, wherein said symbol estimator produces a plurality of symbols estimates for each user; and
  11. a bank of decoders coupled to said symbol estimator, producing a plurality of symbol likelihood estimates for each user, wherein said symbol likelihood estimates are iteratively fed back to said symbol estimator and said joint amplitude estimator until a final condition is obtained.
1. 2. The apparatus according to claim 1, wherein said final condition is selected from at least one of the group consisting of: bit error rate metric level and fixed number of iterations.
1. 3. The apparatus according to claim 1, wherein said symbol hypothesis testing module is a member selected from at least one member of the group consisting of: Minimum Mean Squared Error (MMSE), maximum likelihood, M-algorithm, T-algorithm, and Q-algorithm, decorrelating decision-feedback detector (DDFD), improved decorrelating decision-feedback detector (IDDFD), successive interference cancellation (SIC), parallel interference cancellation (PIC) and multi-stage detector; block-iterative interference cancellation, and a deferred decorrelating decision-feedback detector.

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1       4. The apparatus according to claim 1, further comprising an energy detector  
2                   coupled to said joint amplitude estimator.

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1       5. The apparatus according to claim 1, wherein said bank of decoders are  
2                   decoders selected from at least one decoder of the group consisting of: Soft-  
3                   output Viterbi , Maximum A Posteriori , and BCJR.

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1       6. A method for providing initial amplitude estimation for a plurality of user  
2                   channels, comprising:

3                   separating said user channels into active channels and inactive channels;  
4                   processing said inactive channels according to the sub-steps comprising:

5                       applying a bank of filters to said inactive channels for each inactive  
6                       user;

7                       squaring an output from said bank of filters;

8                       summing an output from said squaring operation; and

9                       calculating an average bias estimate from an output of said  
10                       summing; and

11                   processing said active channels according to the sub-steps comprising:

12                       applying a bank of filters to said user data of said active channels;

13                       squaring an output from said bank of filters ;

14                       summing an output from said squaring; and

15                       removing said average bias estimate from an output from said  
16                       summing.

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1       7. The method according to claim 6, said processing said inactive channels  
2                   further comprising dividing said inactive channels into groups and  
3                   calculating at least one group average bias estimate.

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1       8. The method according to claim 7, said processing said active channels  
2       further comprising dividing said active channels into groups and  
3       respectively removing said at least one group average bias estimate.  
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1       9. The method according to claim 6, wherein said summers further comprises  
2       scaling.  
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1       10. The apparatus according to claim 6, wherein said separating said active  
2       channel from said inactive channels is performed by an energy detector.  
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1       11. An apparatus for processing initial amplitude estimates from a data stream  
2       of multiple users, comprising:  
3            an energy detector measuring an energy level of said data stream, wherein  
4            said energy detector separates a plurality of active channels from a plurality of  
5            inactive channels;  
6            a bank of filters coupled to said inactive channels;  
7            a bank of squaring operators coupled to said bank of filters;  
8            a bank of inactive summers coupled to said squaring operators;  
9            an average bias estimator coupled to said inactive summers calculating an  
10          average bias estimate;  
11          a bank of filters coupled to said active channels;  
12          a bank of squaring operators coupled to said bank of filters;  
13          a bank of active summers coupled to said squaring operators; and  
14          a bias removal section coupled to said active summers and said average bias  
15          estimator.  
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1       12. The apparatus according to claim 11, wherein said inactive channels are  
2       divided into groups calculating said average bias estimate for each said  
3       group.  
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1       13. The apparatus according to claim 12, wherein said active channels are  
2       divided into said groups and wherein said bias removal section for each said  
3       group removes said average bias estimate for each said corresponding  
4       group.

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1       14. A joint amplitude estimator for a data stream from multiple users,  
2       comprising:  
3       a data stream from said multiple users divided into a plurality of  
4       observation intervals;  
5       a plurality of processing modules coupled to said observation intervals,  
6       wherein said processing modules calculates interference cancellation values  
7       for each of said users and computes a filter for each of said observation  
8       intervals, said filter being applied to said data within said observation  
9       interval to compute individual amplitude estimates; and  
10      an amplitude estimation unit which processes said individual amplitude  
11      estimates and calculates new amplitude estimates, wherein said new  
12      amplitude estimates are iteratively passed back to said processing modules  
13      until a final condition is obtained.

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1       15. The joint amplitude estimator according to claim 14, wherein said final  
2       condition is selected from at least one of the group consisting of: bit error  
3       rate metric level and fixed number of iterations.

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1       16. The joint amplitude estimator according to claim 14, wherein said  
2       amplitude estimation unit sums and weighs said individual estimates.

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1       17. The joint amplitude estimator according to claim 14, wherein said  
2       observation intervals are based on distinguishing attributes selected from at  
3       least one of the group consisting of: time, code, and frequency.

1 18. The joint amplitude estimator according to claim 14, wherein said filter is  
2 calculated for an arbitrary observation interval  $m$  as:

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$$G_m = \mathbf{B}_m \mathbf{S}_m^H \left( \mathbf{S}_m \mathbf{S}_m^H + \sigma_n^2 I \right)^{-1}.$$

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1 19. A method for processing amplitude estimates for a multiuser data stream  
2 divided into a plurality of observation intervals, comprising:

3 computing a filter for each said observation interval of said data stream;  
4 applying interference cancellation to said data stream for each said  
5 observation interval;

6 applying said filter to said data stream for each said observation interval  
7 from said interference cancellation to produce individual amplitude  
8 estimates for each said observation interval;

9 computing new amplitude estimates using said individual amplitude  
10 estimates; and

11 passing said new amplitude estimates back to said filter for iterative  
12 processing until a final condition is obtained.

13  
1 20. The method according to claim 19, wherein said computing further  
2 comprises summing said individual amplitude estimates and weighing.

3  
1 21. The method according to claim 19, wherein said final condition is selected  
2 from at least from the group consisting of: bit error rate metric level and  
3 fixed number of iterations.

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1 22. A turbo-decoding system for joint signal demodulation, comprising:  
2 a data stream from a plurality of users divided into a plurality of observation  
3 intervals;

4                   a plurality of symbol processing nodes processing said observation intervals  
5                   to compute symbol estimates for said data stream within said observation  
6                   interval;

7                   a plurality of decoder nodes processing said symbol estimates and  
8                   producing a plurality of symbol likelihoods;

9                   a plurality of amplitude update nodes processing said symbol likelihoods  
10                  and calculating a plurality of amplitude update vectors; and

11                  an amplitude estimator node processing said amplitude update vectors and  
12                  producing an amplitude estimate update, wherein said amplitude estimate  
13                  update is passed back to said processing nodes for iterative processing  
14                  between said symbol processing nodes, said decoder nodes, said amplitude  
15                  update nodes, and said amplitude estimator node until a final condition is  
16                  obtained.

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1                  23. The system according to claim 22, further comprising a plurality of memory  
2                  units, wherein at least one memory unit is coupled to each of said  
3                  processing nodes and to each of said amplitude estimation nodes.

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1                  24. The system according to claim 22, further comprising a first system area  
2                  network (SAN) coupling said processing nodes and said decoder nodes, a  
3                  second system area network (SAN) coupling said decoder nodes and said  
4                  amplitude estimation nodes, a third system area network (SAN) coupling  
5                  said amplitude estimation nodes and said amplitude estimator, and a fourth  
6                  system area network (SAN) coupling said amplitude estimator and said  
7                  processing nodes.

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1                  25. The system according to claim 22, wherein said final condition is selected  
2                  from at least one of the group consisting of: bit error rate metric level and  
3                  fixed number of iterations.

26. The system according to claim 22, wherein said processing nodes, said decoder nodes and said amplitude estimation nodes are one set of nodes.
27. The system according to claim 26, wherein said one set of nodes are each comprised of at least one processor.
28. The system according to claim 22, wherein said likelihood symbols from said decoder nodes are accessible at any time for post-processing.
29. The system according to claim 22, wherein said processing nodes further comprises a threshold to convert said symbol estimates to symbol bits.
30. The system according to claim 22, wherein said decoder nodes performs de-interleaving, rate identification, de-puncturing and de-scrambling.